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# ***CadSoft EAGLE Training Extended***

The slides you will see in the following give an overview of topics addressed for EAGLE. You will get details and practicing in my course.

Please find more on booking and pricing here:

[http://www.blunk-electronic.de/pdf/topics\\_EAGLE\\_training.pdf](http://www.blunk-electronic.de/pdf/topics_EAGLE_training.pdf)

# *Overview*

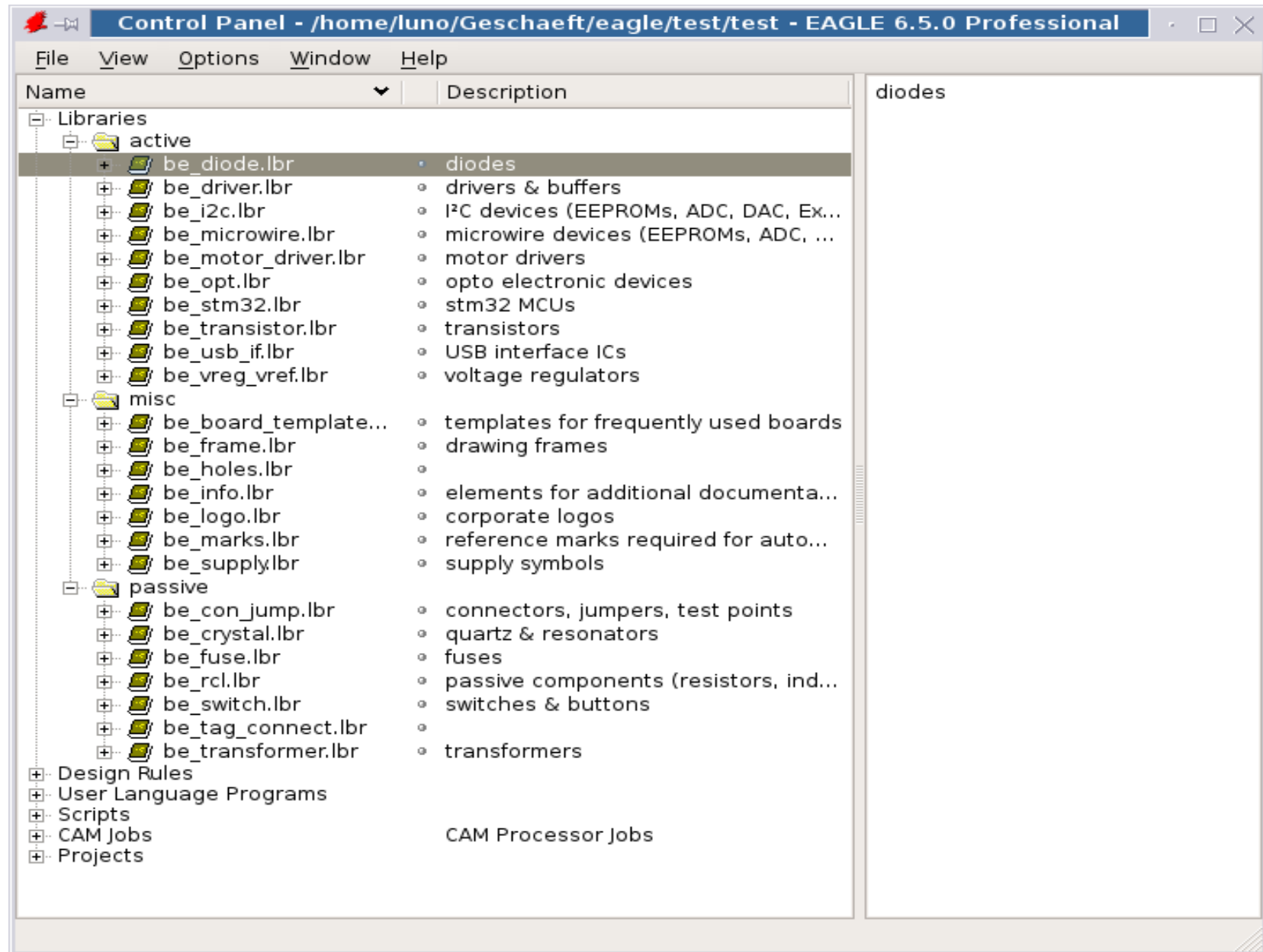
- ▶ structuring the library
- ▶ part management and bill of material (BOM)
- ▶ slitted holes, drills for heat dissipation
- ▶ hierarchic net names
- ▶ modularizing schematic and layout
- ▶ drawing frame / title block
- ▶ CAM processor

# *Library Structure #1*

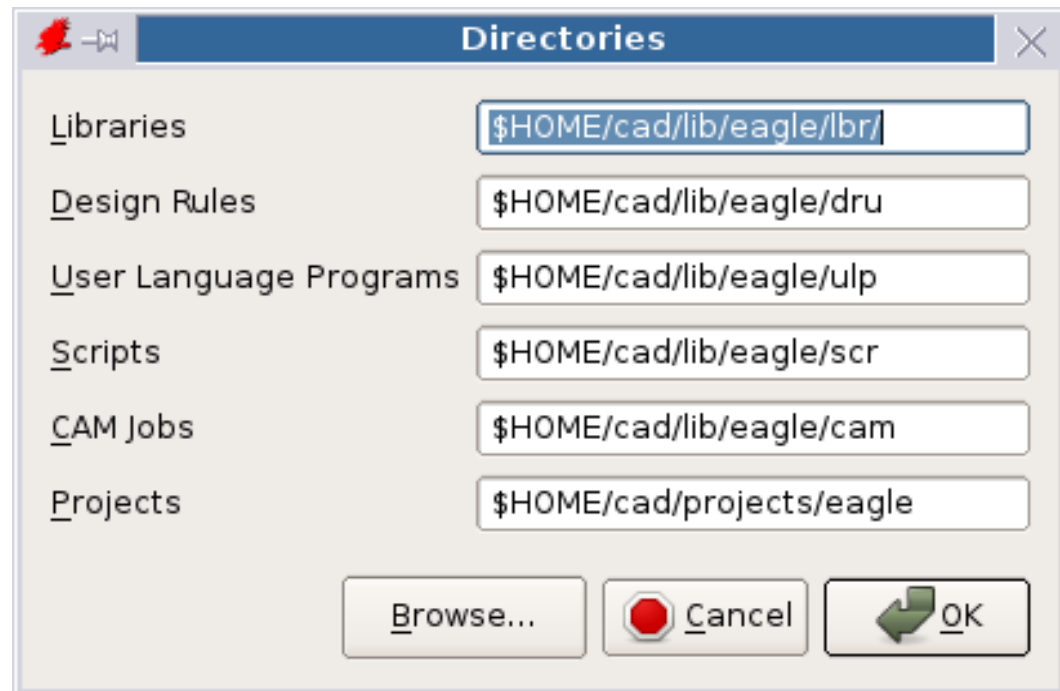
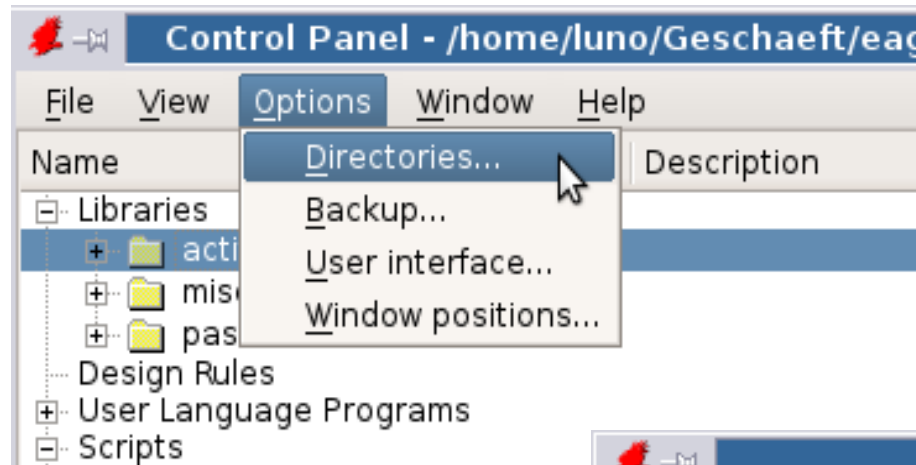
- ◆ reducing data traffic
- ◆ coarse categorizing active, passive, misc parts
- ◆ separate own from foreign/external libraries
- ◆ reliability

[https://github.com/Blunk-electronic/lbr\\_eagle/tree/master/lbr](https://github.com/Blunk-electronic/lbr_eagle/tree/master/lbr)

# Library Structure #2

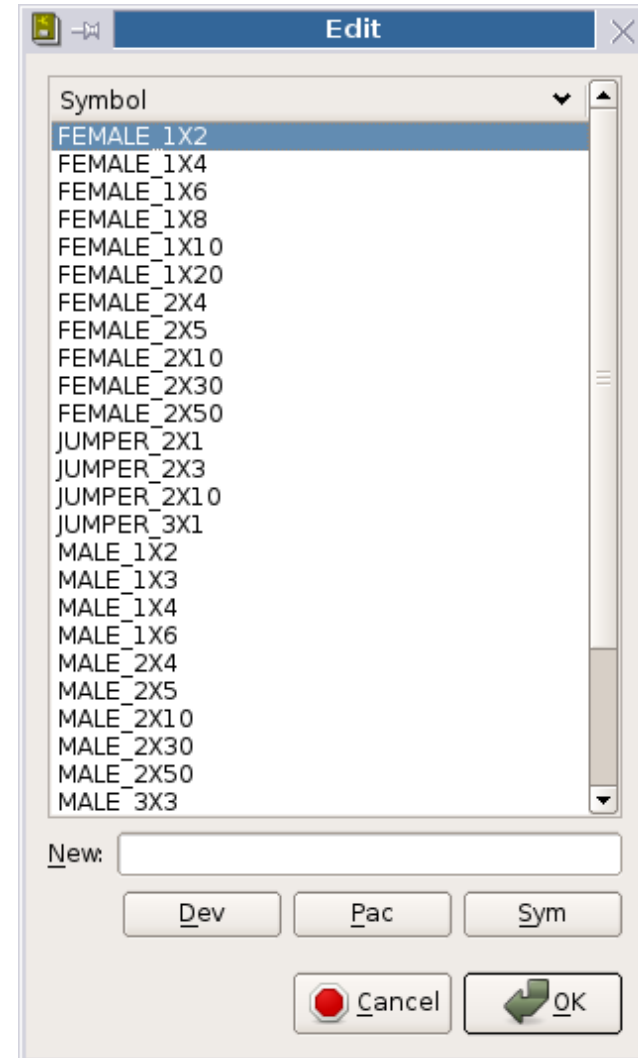
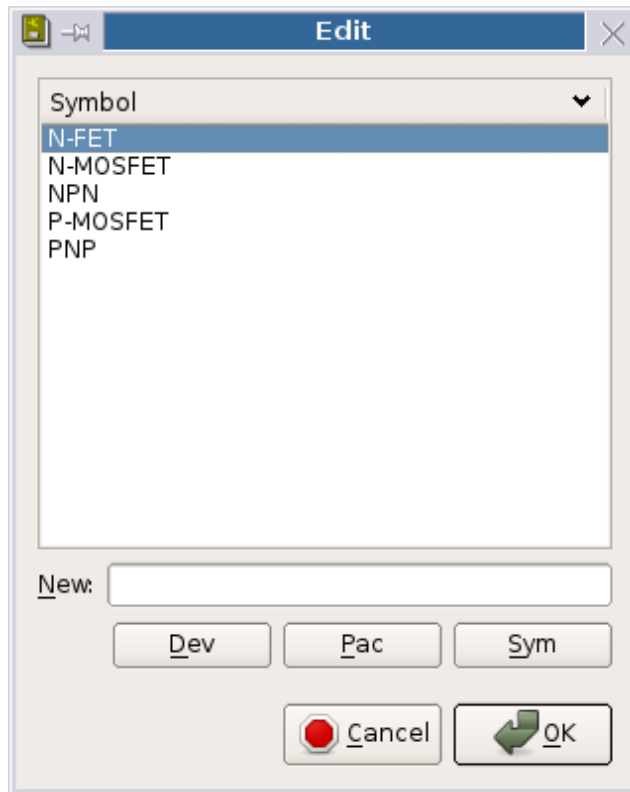


# Library Structure #3



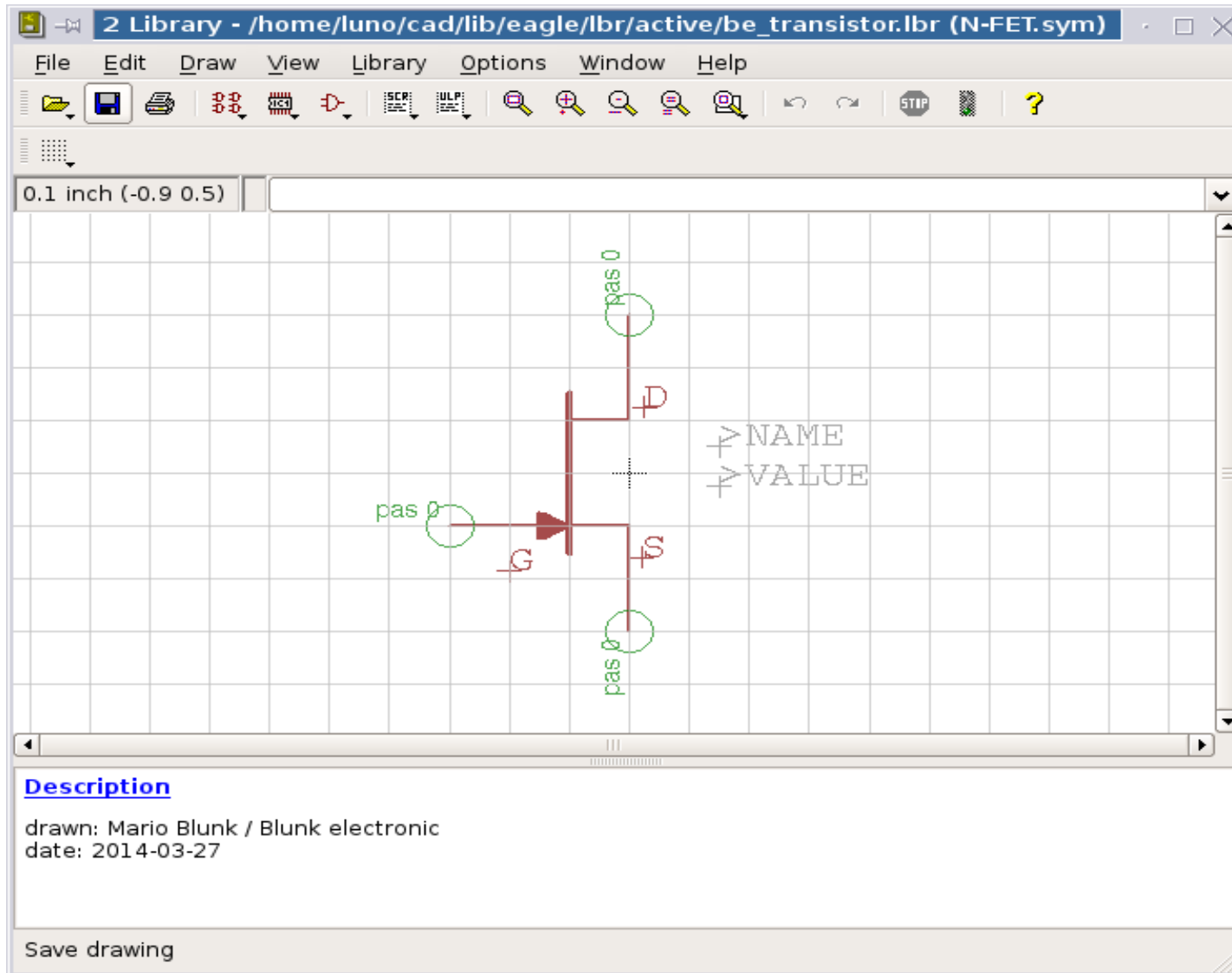
# Library Structure #4

Symbol Names:



# Library Structure #5

## Symbol Description:



The screenshot shows the EAGLE library editor interface. The title bar reads "2 Library - /home/luno/cad/lib/eagle/lbr/active/be\_transistor.lbr (N-FET.sym)". The menu bar includes File, Edit, Draw, View, Library, Options, Window, and Help. The toolbar contains various icons for file operations, drawing, and editing. The main workspace displays a grid with a transistor symbol drawn in red. The symbol has three terminals: a gate terminal labeled "G" on the left, a drain terminal labeled "D" at the top, and a source terminal labeled "S" at the bottom. Each terminal is connected to a green circle labeled "pas 0". To the right of the symbol, there are two text labels: "NAME" and "VALUE", each with a small arrow pointing to the right. The status bar at the bottom left shows "Save drawing".

0.1 inch (-0.9 0.5)

NAME  
VALUE

**Description**

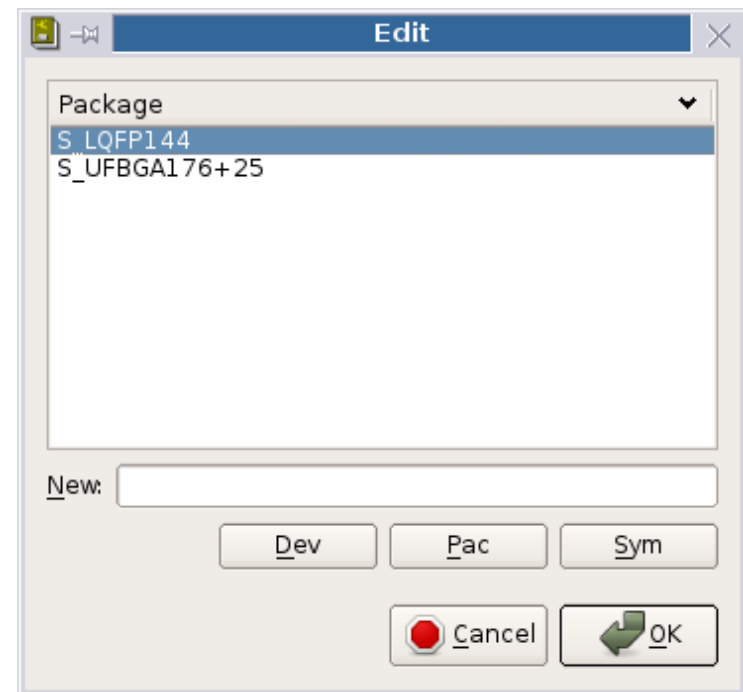
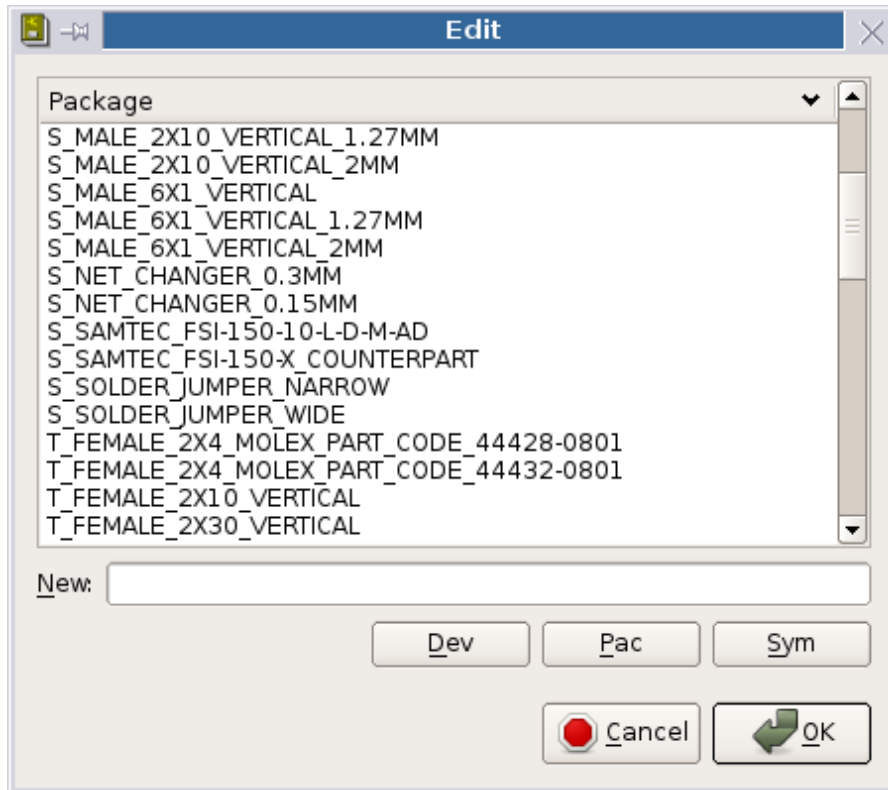
drawn: Mario Blunk / Blunk electronic  
date: 2014-03-27

Save drawing



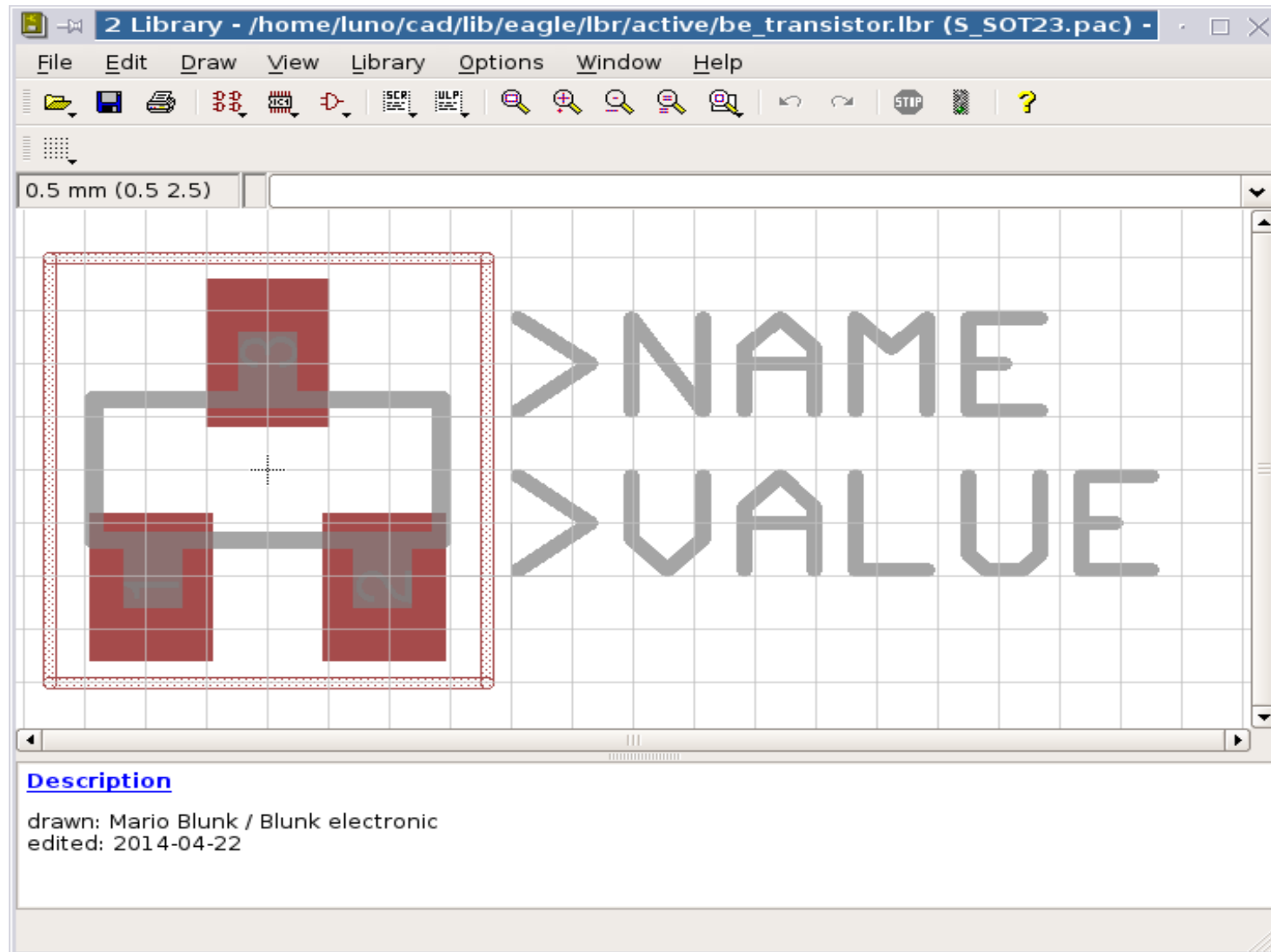
# Library Structure #6

## Package Names:



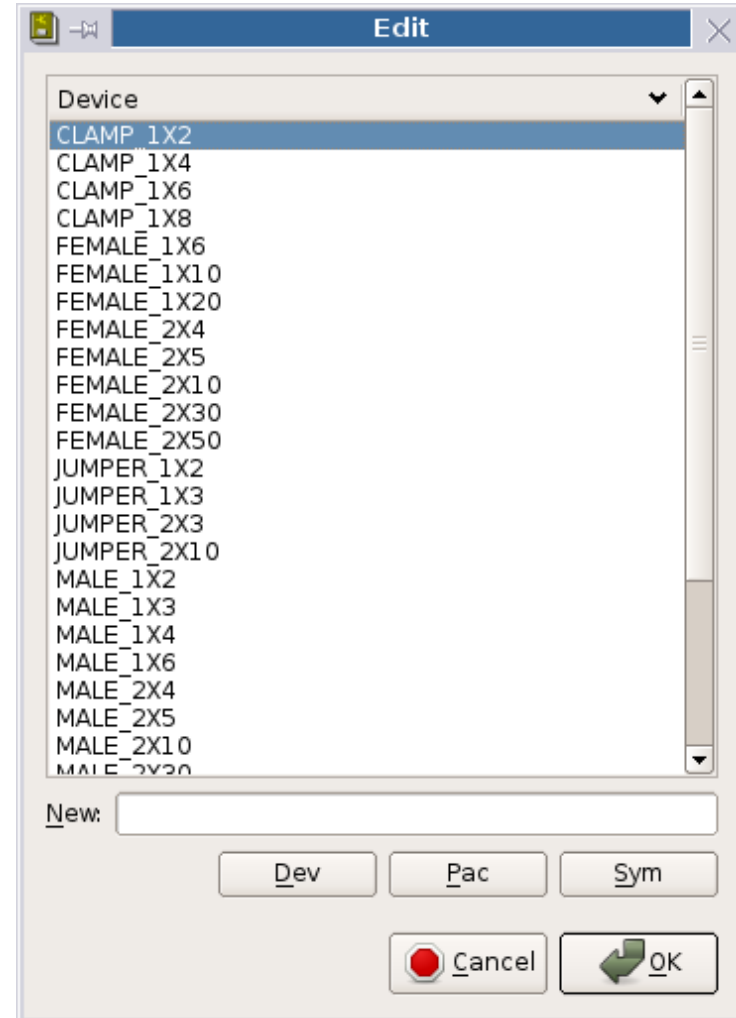
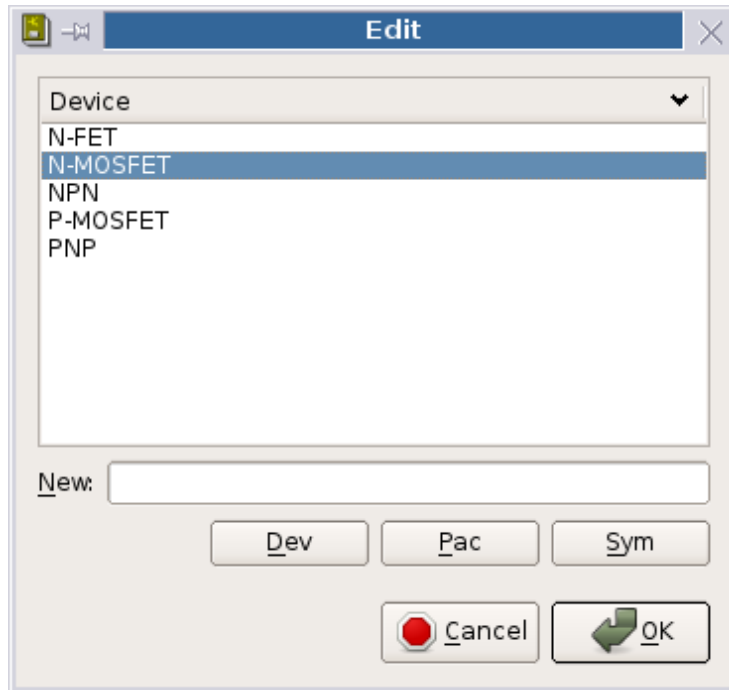
# Library Structure #7

## Package Description:



# Library Structure #8

## Device Names:



# Library Structure #9

## Device Editor:

The screenshot shows the EAGLE 6.5.0 Professional Device Editor interface. The main workspace displays a schematic diagram of an N-FET with pins labeled 1, 2, 3, D, G, and S. Annotations include "Add=next Swap=0" in green, "pas 0" in green circles, and "G\$1 >VALUE" in grey. The top menu bar includes File, Edit, Draw, View, Library, Options, Window, and Help. The toolbar contains various icons for file operations, drawing, and editing. The status bar at the bottom left shows "0.1 inch (1.2 -0.2)".

On the right side, a panel displays a schematic symbol for the N-FET, a scale bar (5mm / 0.2in), and a table for Package and Variant selection. The table shows "S\_SOT23" selected with a green checkmark.

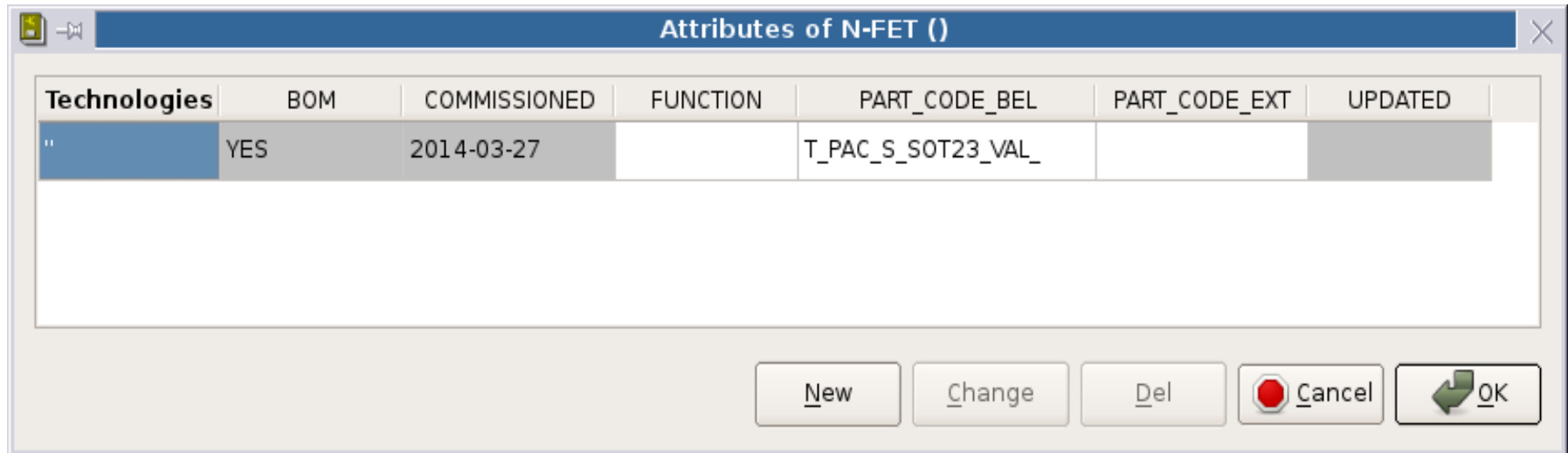
At the bottom, a "Description" section contains the text "drawn: Mario Blunk / Blunk electronic". To its right is a table with columns for Technologies and Attributes.

Technologies		Attributes				
	BOM	COMMISSIONED	FUNCTION	PART_CODE_BEL	PART_CODE_EXT	UPDATED
N-FET	YES	2014-03-27		T_PAC_S_SOT23_VAL		

Below the table are buttons for "New" and "Connect", a "Prefix" field with the value "T", and a "Value" section with radio buttons for "Off" and "On".

# Library Structure #10

## Device Attributes:

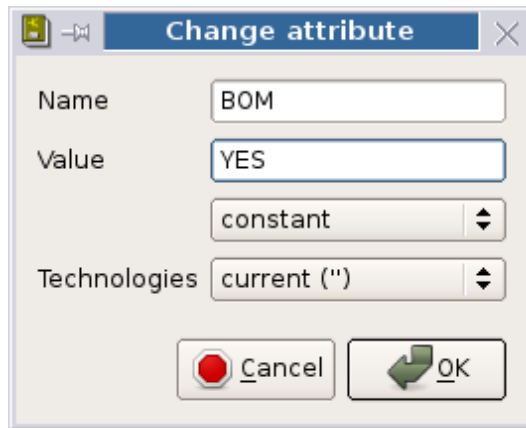


Technologies	BOM	COMMISSIONED	FUNCTION	PART_CODE_BEL	PART_CODE_EXT	UPDATED
"	YES	2014-03-27		T_PAC_S_SOT23_VAL_		

Buttons:

# Library Structure #11

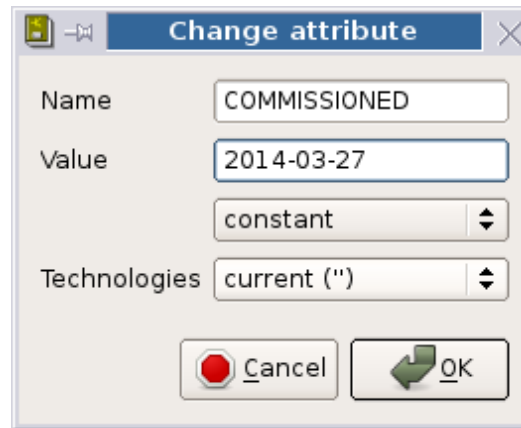
## Device Attributes:



Change attribute dialog box showing Name: BOM, Value: YES, constant type, and Technologies: current ("").

Name	BOM
Value	YES
Type	constant
Technologies	current ("")

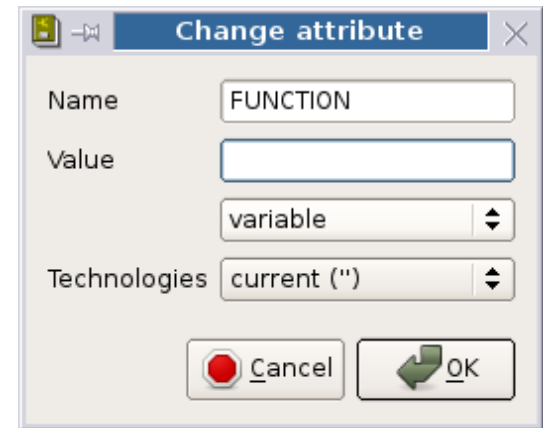
Buttons: Cancel, OK



Change attribute dialog box showing Name: COMMISSIONED, Value: 2014-03-27, constant type, and Technologies: current ("").

Name	COMMISSIONED
Value	2014-03-27
Type	constant
Technologies	current ("")

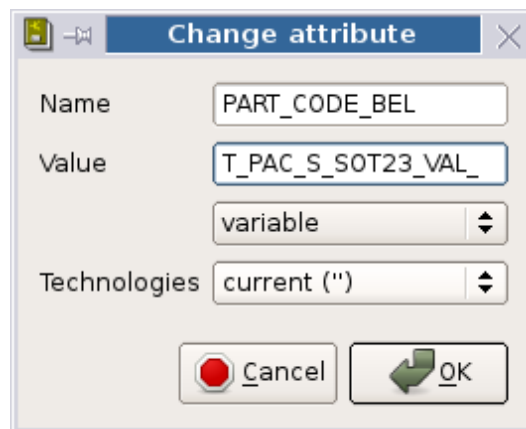
Buttons: Cancel, OK



Change attribute dialog box showing Name: FUNCTION, Value: (empty), variable type, and Technologies: current ("").

Name	FUNCTION
Value	
Type	variable
Technologies	current ("")

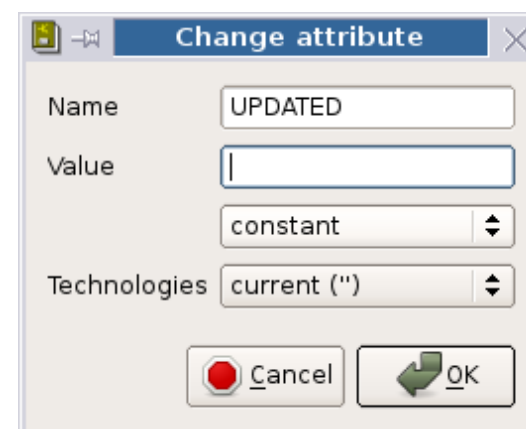
Buttons: Cancel, OK



Change attribute dialog box showing Name: PART\_CODE\_BEL, Value: T\_PAC\_S\_SOT23\_VAL\_, variable type, and Technologies: current ("").

Name	PART_CODE_BEL
Value	T_PAC_S_SOT23_VAL_
Type	variable
Technologies	current ("")

Buttons: Cancel, OK



Change attribute dialog box showing Name: UPDATED, Value: (empty), constant type, and Technologies: current ("").

Name	UPDATED
Value	
Type	constant
Technologies	current ("")

Buttons: Cancel, OK

# *Part Management & BOM #1*

## **CadSoft EAGLE is no Resource Planning System !**

- ◆ Part Code Attribute is primary key to external part data base
- ◆ external data base contains order codes, manufacturer codes, datasheets, prices, ...

1. preparation in library: PART\_CODE\_BEL

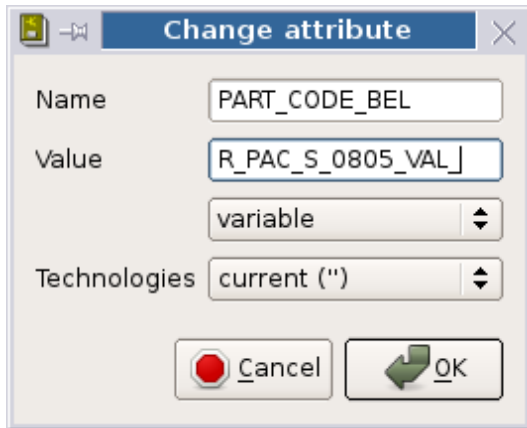
2. refinement in schematic: PART\_CODE\_BEL

3. execute ULP: BOM

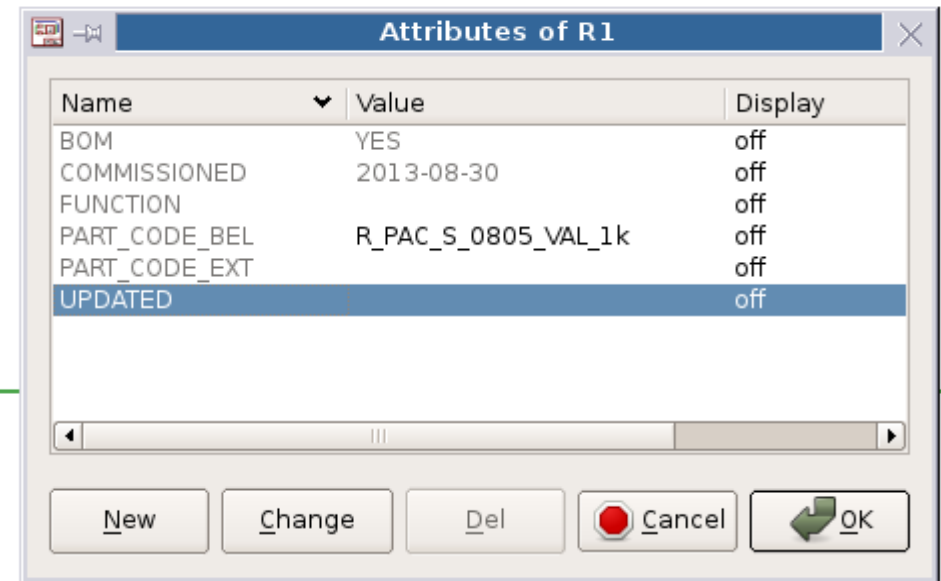
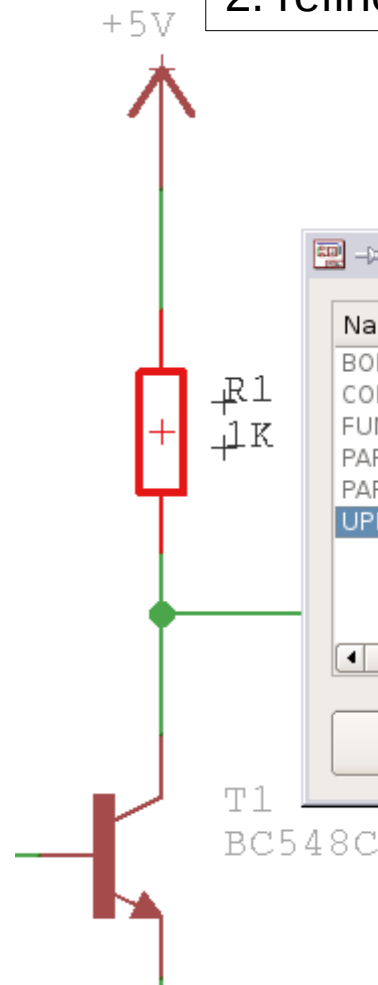
4. run external SW: Stock Manager

# Part Management & BOM #2

1. preparation in library: PART\_CODE\_xyz



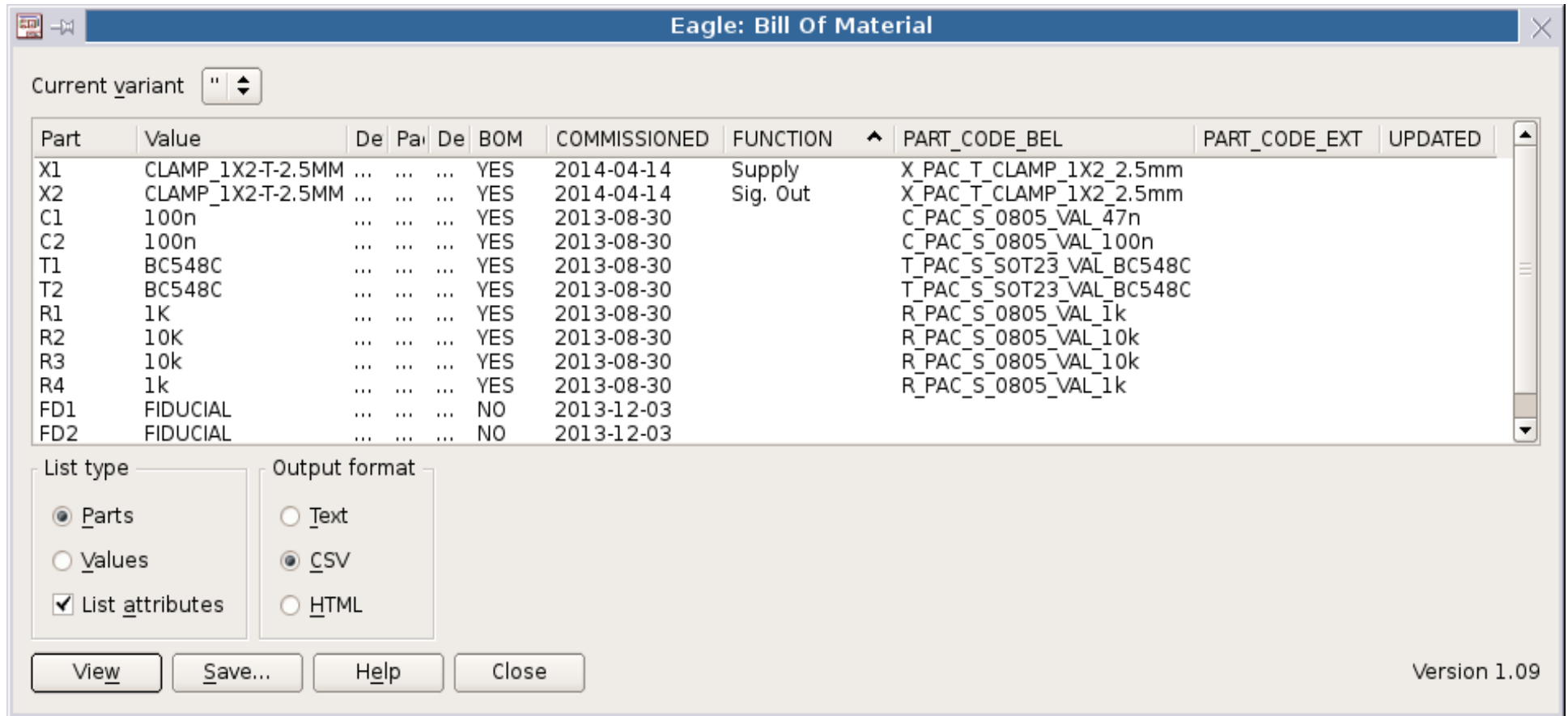
2. refinement in schematic: PART\_CODE\_xyz





# Part Management & BOM #3

## 3. execute ULP: BOM



The screenshot shows the 'Eagle: Bill of Material' window. The title bar reads 'Eagle: Bill of Material'. Below the title bar, there is a 'Current variant' dropdown menu showing an empty string. The main area contains a table with the following columns: Part, Value, De, Pa, De, BOM, COMMISSIONED, FUNCTION, PART\_CODE\_BEL, PART\_CODE\_EXT, and UPDATED. The table lists 14 parts (X1, X2, C1, C2, T1, T2, R1, R2, R3, R4, FD1, FD2) with their respective values and attributes. Below the table, there are two groups of radio buttons: 'List type' with options 'Parts' (selected), 'Values', and 'List attributes' (checked); and 'Output format' with options 'Text', 'CSV' (selected), and 'HTML'. At the bottom, there are four buttons: 'View', 'Save...', 'Help', and 'Close'. The version number 'Version 1.09' is displayed in the bottom right corner.

Part	Value	De	Pa	De	BOM	COMMISSIONED	FUNCTION	PART_CODE_BEL	PART_CODE_EXT	UPDATED
X1	CLAMP_1X2-T-2.5MM	...	...	...	YES	2014-04-14	Supply	X_PAC_T_CLAMP_1X2_2.5mm		
X2	CLAMP_1X2-T-2.5MM	...	...	...	YES	2014-04-14	Sig. Out	X_PAC_T_CLAMP_1X2_2.5mm		
C1	100n	...	...	...	YES	2013-08-30		C_PAC_S_0805_VAL_47n		
C2	100n	...	...	...	YES	2013-08-30		C_PAC_S_0805_VAL_100n		
T1	BC548C	...	...	...	YES	2013-08-30		T_PAC_S_SOT23_VAL_BC548C		
T2	BC548C	...	...	...	YES	2013-08-30		T_PAC_S_SOT23_VAL_BC548C		
R1	1K	...	...	...	YES	2013-08-30		R_PAC_S_0805_VAL_1k		
R2	10K	...	...	...	YES	2013-08-30		R_PAC_S_0805_VAL_10k		
R3	10k	...	...	...	YES	2013-08-30		R_PAC_S_0805_VAL_10k		
R4	1k	...	...	...	YES	2013-08-30		R_PAC_S_0805_VAL_1k		
FD1	FIDUCIAL	...	...	...	NO	2013-12-03				
FD2	FIDUCIAL	...	...	...	NO	2013-12-03				

# Part Management & BOM #4

## 4. Run external SW: *Stock Manager*

transceiver\_m1.csv - LibreOffice Calc

File Edit View Insert Format Tools Data Window Help

Liberation Sans 10

A3 board: transceiver\_m1.csv

POS.	QTY	PART_NAME	PART_CODE_BEL	PART_ID	PRICE_NET_MIN	PRICE_NET_MAX
1	1	C501	C_PAC_S_0805_VAL_100n	13	0.01	0.04
2	1	IC501	IC_PAC_S_SOIC8_VAL_24LC256-1/5N	56	0.63	0.87
3	2	LED601, LED1302	LED_PAC_S_0805_VAL_red	99	0.46	0.46
4	1	LED602	LED_PAC_S_0805_VAL_green	98	0.23	0.23
5	2	LED603, LED1301	LED_PAC_S_0805_VAL_blue	97	0.46	0.46
6	6	R501, R502, R503, R504, R505, R506	R_PAC_S_0805_VAL_4k7	133	0.24	0.24
7	5	R601, R603, R605, R1301, R1303	R_PAC_S_0805_VAL_1M	147	0.05	0.05
8	2	R602, R1304	R_PAC_S_0805_VAL_1k5	150	0.04	0.04
9	1	R604	R_PAC_S_0805_VAL_330	158	0.03	0.03
10	2	R606, R1302	R_PAC_S_0805_VAL_820	316	0.06	0.06
11	1	R1101	R_PAC_S_0805_VAL_0	138	0.01	0.01
12	5	T601, T602, T603, T1301, T1302	T_PAC_S_SOT23_VAL_DMG3420U	202	0.60	1.25
13	7	XD601, XD803, XD1201, XD1301, XS601, XS1101, XS1301	X_PAC_T_MALE_1x6_VERTICAL_GRID_2.54mm	267	3.15	3.15
14	3	XD801, XD802, XD1001	X_PAC_S_MALE_2X10_VERTICAL_GRID_2mm	229	4.23	4.23
15	1	XD1302	X_PAC_T_MALE_3X1_VERTICAL	264	0.08	0.08
16	3	XS701, XS702, XS901	X_PAC_S_FEMALE_1x20_VERTICAL_GRID_1mm	219	3.54	3.54
17	1	XS703	X_PAC_S_FEMALE_1x6_VERTICAL_GRID_1mm	222	0.50	0.50
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Sheet 1 / 1 Default Sum=0 100%

# Part Management & BOM #5

part data base csv formatted

stock\_db.csv (read-only) - LibreOffice Calc

File Edit View Insert Format Tools Data Window Help

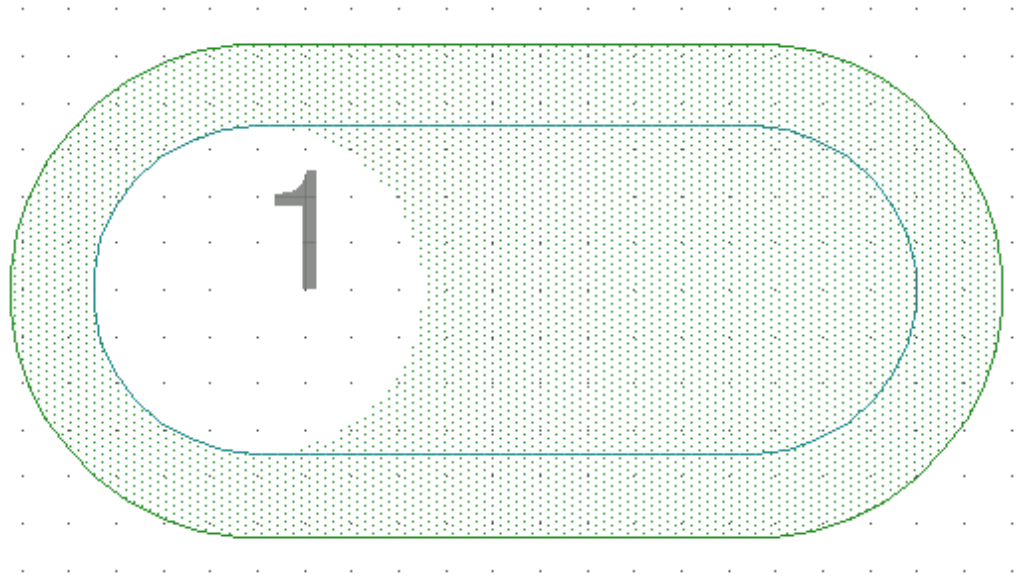
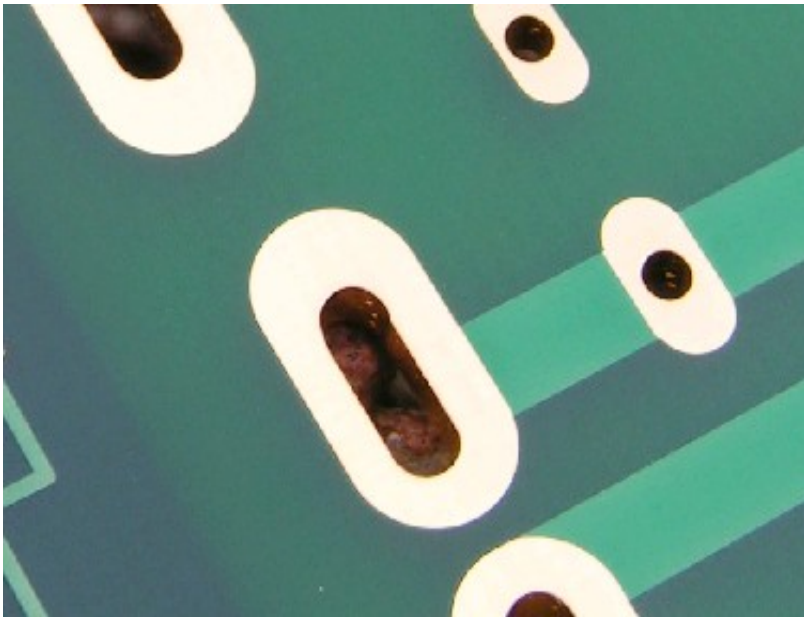
A1 MATERIAL ON STOCK

	A	B	C	D	E	F
1	MATERIAL ON STOCK					
2	-----					
3	created by STOCK MANAGER	V007				
4	date:	2015-06-04 10:28:15	(YYYY-MM-DD HH:MM:SS)			
5						
6	PART_ID	PART_CODE_BEL	DATE_EDITED	QTY_ON_STOCK	QTY_RESERVED	QTY_AVA
7	1	C_PAC_S_0402_VAL_100n_Vmax_25V	2015-03-13 17:10:34	0	0	0
8	2	C_PAC_S_0402_VAL_18p	2015-03-13 17:10:34	0	0	0
9	3	C_PAC_S_0603_VAL_100n	2015-03-13 17:10:34	0	0	0
10	4	C_PAC_S_0603_VAL_100n_Vmax_100V	2015-05-13 09:47:51	15	0	15
11	5	C_PAC_S_0603_VAL_10n	2015-05-13 10:35:57	9	0	9
12	6	C_PAC_S_0603_VAL_10n_Vmax_50V	2015-03-13 17:10:34	0	0	0
13	7	C_PAC_S_0603_VAL_12p	2015-03-13 17:10:34	0	0	0
14	8	C_PAC_S_0603_VAL_16p	2015-03-13 17:10:34	0	0	0
15	9	C_PAC_S_0603_VAL_2u2_Vmax_16V	2015-03-13 17:10:34	0	0	0
16	10	C_PAC_S_0603_VAL_33p	2015-05-13 10:39:43	8	0	8
17	11	C_PAC_S_0603_VAL_470n_Vmax_25V	2015-03-13 17:10:34	0	0	0
18	12	C_PAC_S_0603_VAL_9p	2015-03-13 17:10:34	0	0	0
19	13	C_PAC_S_0805_VAL_100n	2015-06-02 14:52:59	242	0	242
20	14	C_PAC_S_0805_VAL_100n_Vmax_100V	2015-05-12 12:14:53	5	0	5
21	15	C_PAC_S_0805_VAL_10n	2015-04-30 10:48:05	9	0	9
22	16	C_PAC_S_0805_VAL_10n_Vmax_100V	2015-05-12 12:11:28	1	0	1
23	17	C_PAC_S_0805_VAL_12p	2015-03-13 17:10:34	0	0	0
24	18	C_PAC_S_0805_VAL_18p	2015-05-12 12:47:22	6	0	6
25	19	C_PAC_S_0805_VAL_2u2_Vmax_25V	2015-03-13 17:10:34	0	0	0
26	20	C_PAC_S_0805_VAL_470n_Vmax_100V	2015-03-13 17:10:34	0	0	0
27	21	C_PAC_S_0805_VAL_9p	2015-03-13 17:10:34	0	0	0
28	22	C_PAC_S_1206_VAL_4u7_Vmax_100V	2015-05-13 10:45:28	1	0	1
29	23	C_PAC_S_3216-18_VAL_10u_Vmax_10V	2015-03-13 17:10:34	0	0	0
30	24	C_PAC_S_6032_VAL_100u_Vmax_16V	2015-03-13 17:10:34	0	0	0
31	25	C_PAC_S_6032_VAL_10u_Vmax_35V	2015-03-13 17:10:34	0	0	0

Sheet1

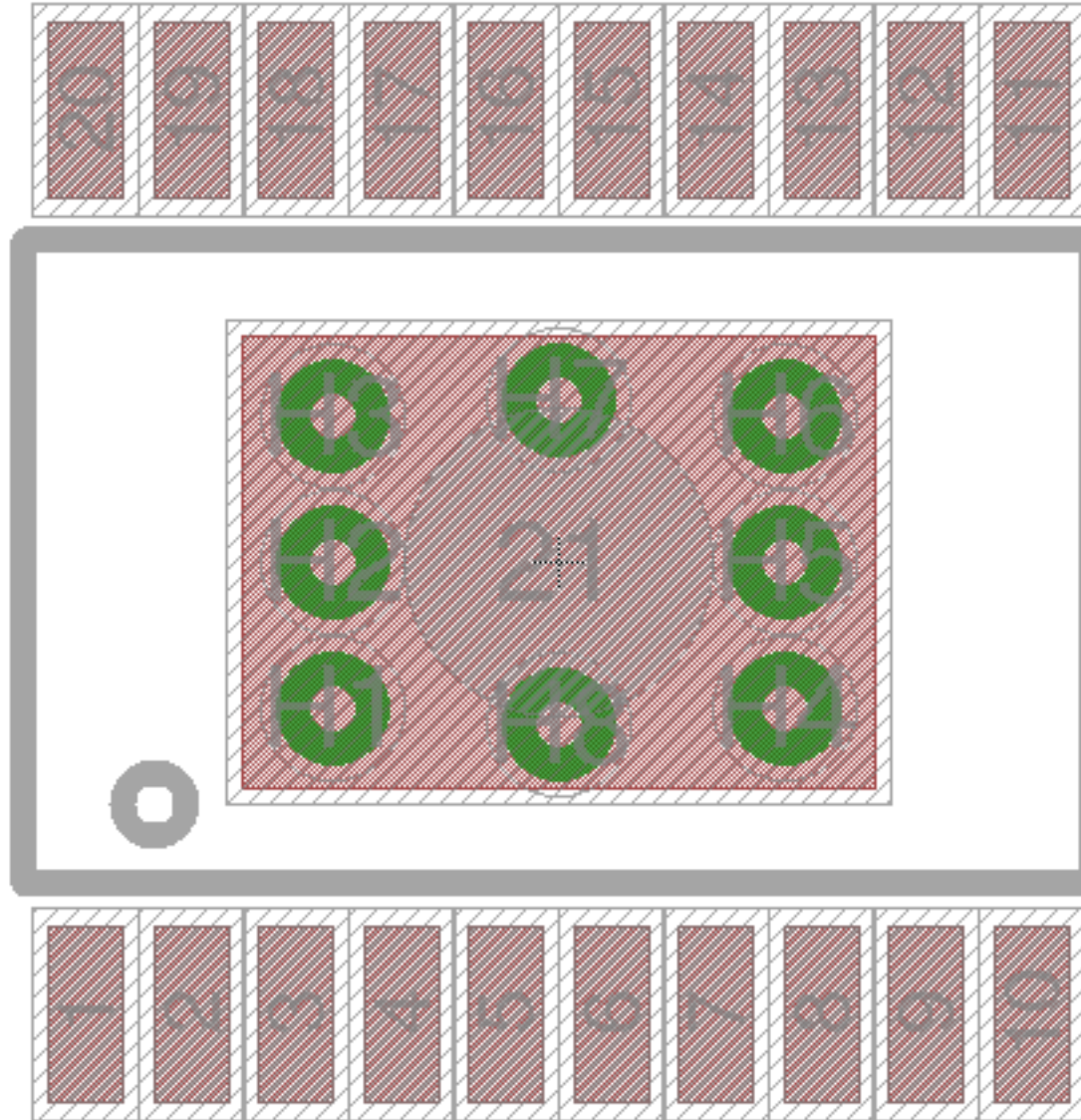
Sheet 1 / 1 Default Sum=0 100%

# Slitted Holes



- no standardization !
- communication with PCB maker (written from)
- **Be cautious with inner layers !**
- read [http://www.blunk-electronic.de/pdf/Design\\_Checklist\\_en.pdf](http://www.blunk-electronic.de/pdf/Design_Checklist_en.pdf)  
section "Slitted Holes in Inner Layers"

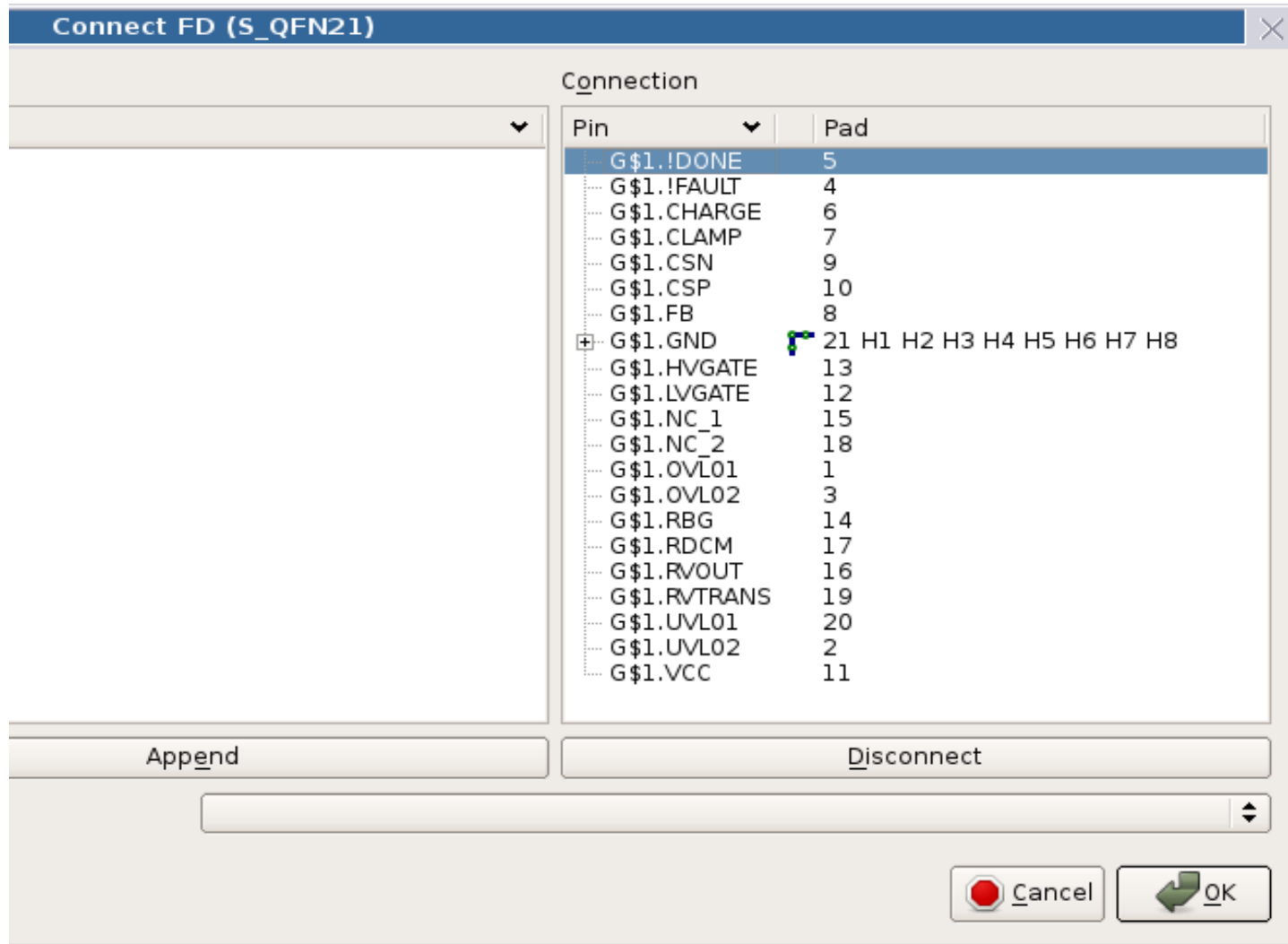
# Drills for Heat Dissipation #1



*Solder mask !*

# Drills for Heat Dissipation #2

append-function in device editor



# ***Net Names #1***

- ▶ schematic structure
- ▶ simplification in layout (unlike something like N\$1701)
- ▶ improved overview
- ▶ prepares modularizing
- ▶ exploiting command line (scripting)

# ***Net Names #2***

Examples:

- ▶ PWR\_VREG\_IN, PWR\_VREG\_OUT, PWR\_VREG\_ADJ
- ▶ CPU\_JTAG\_TCK, CPU\_JTAG\_TMS
- ▶ CPU\_GPIO\_1, CPU\_GPIO\_2
- ▶ +3V3, -12V, GND, ... (*consider net classes !*)

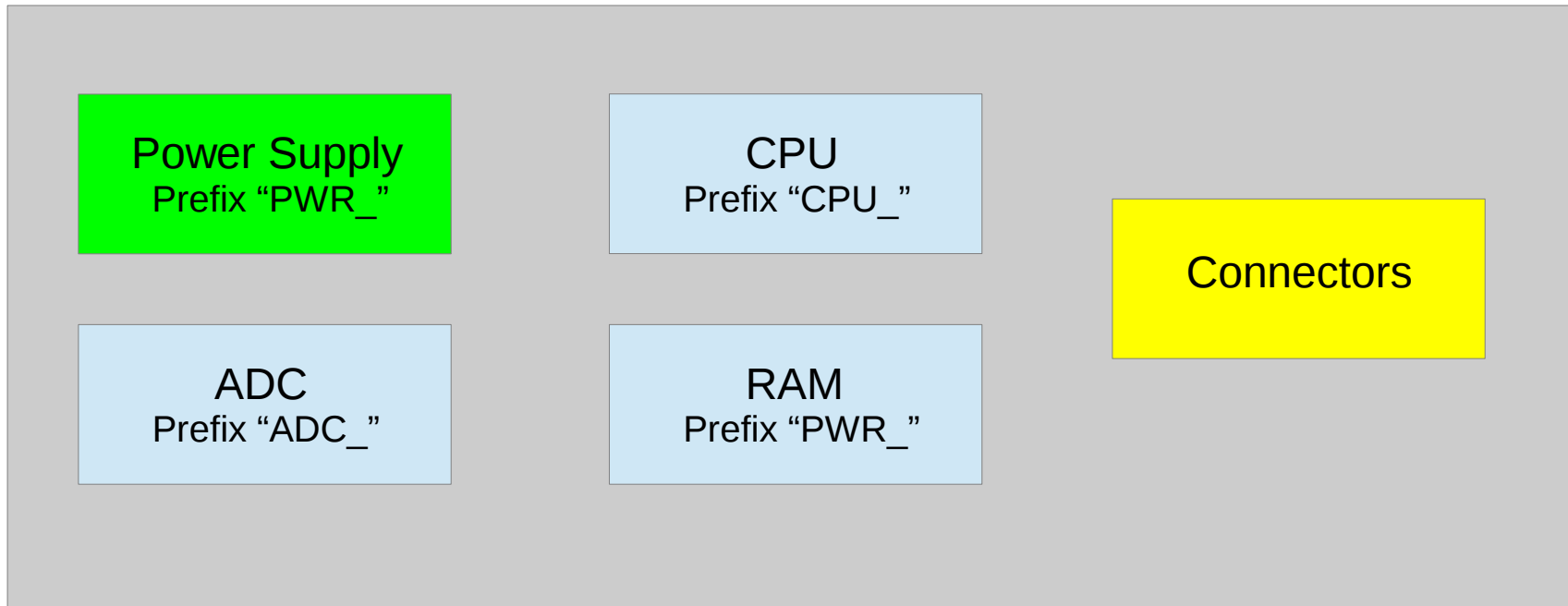
Command Line:

- 1) `route PWR_VREG_IN`
- 2) `show PWR_VREG *`
- 3) `ripup CPU_JTAG_* CPU_GPIO_*`
- 4) `auto CPU_GPIO_*`



# Modularizing #1

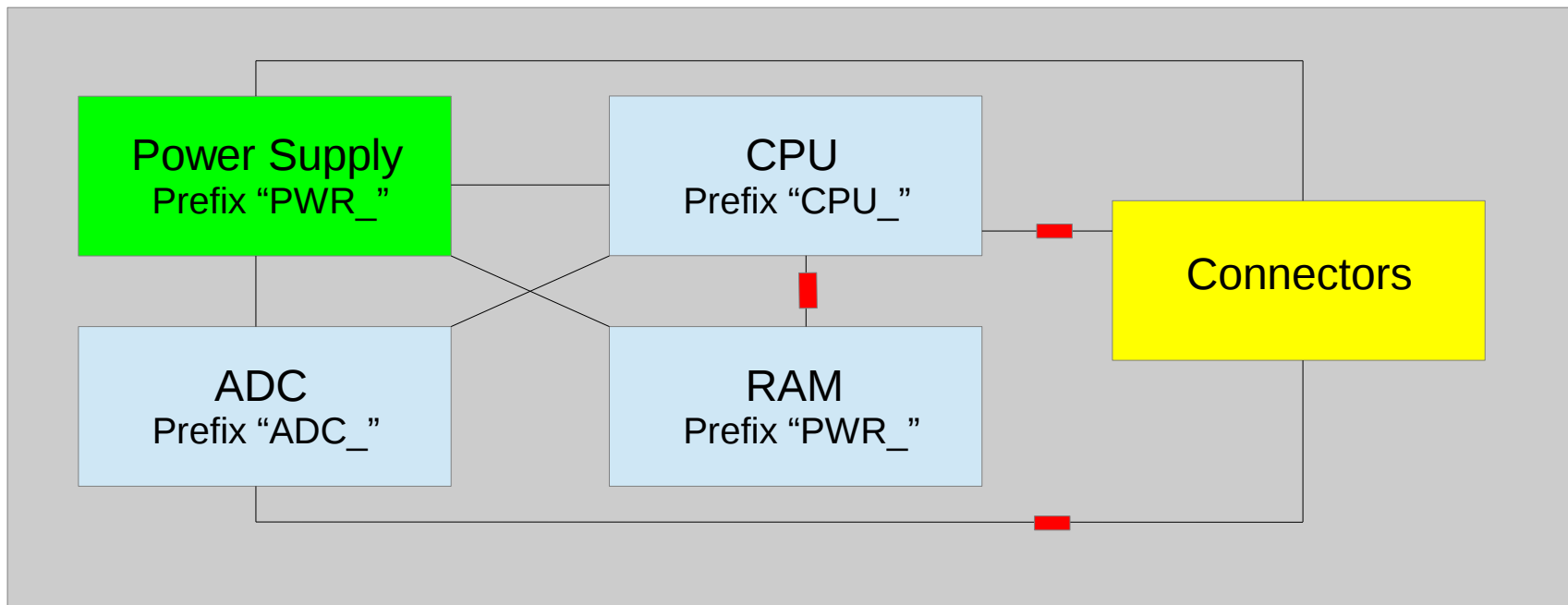
- ▶ project structure
- ▶ re-usability
- ▶ Pay attention to net classes, design rules, layer usage !



# Modularizing #2

Module Interconnections:

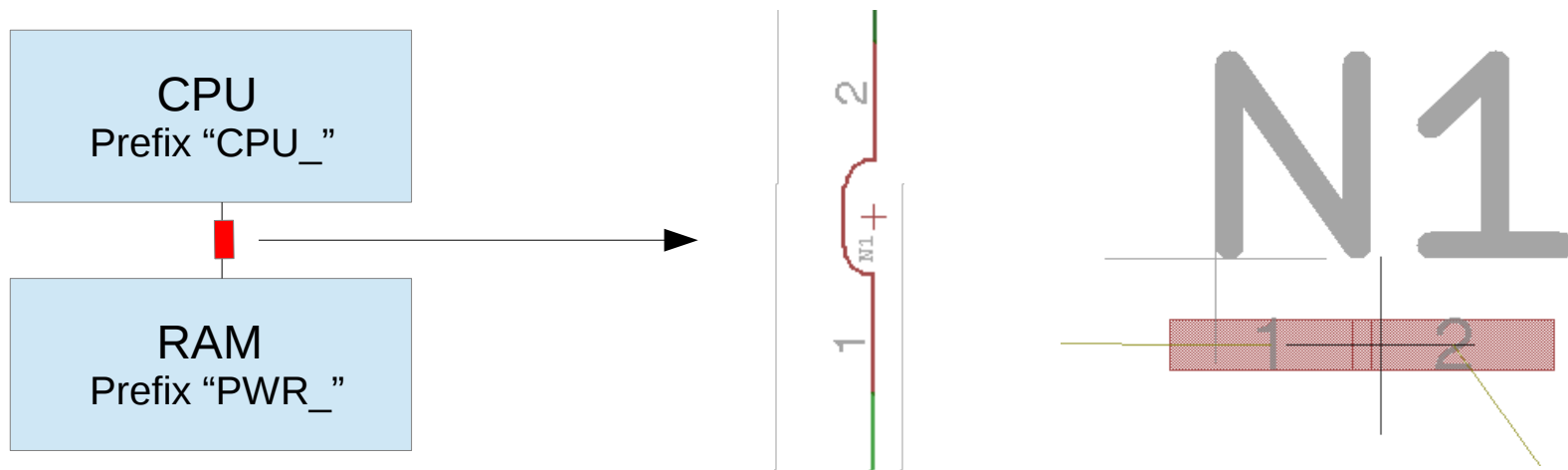
- ◆ EAGLE function “*Import Drawing*”
- ◆ via (matching) net names
- ◆ ports (so called “netchangers”)



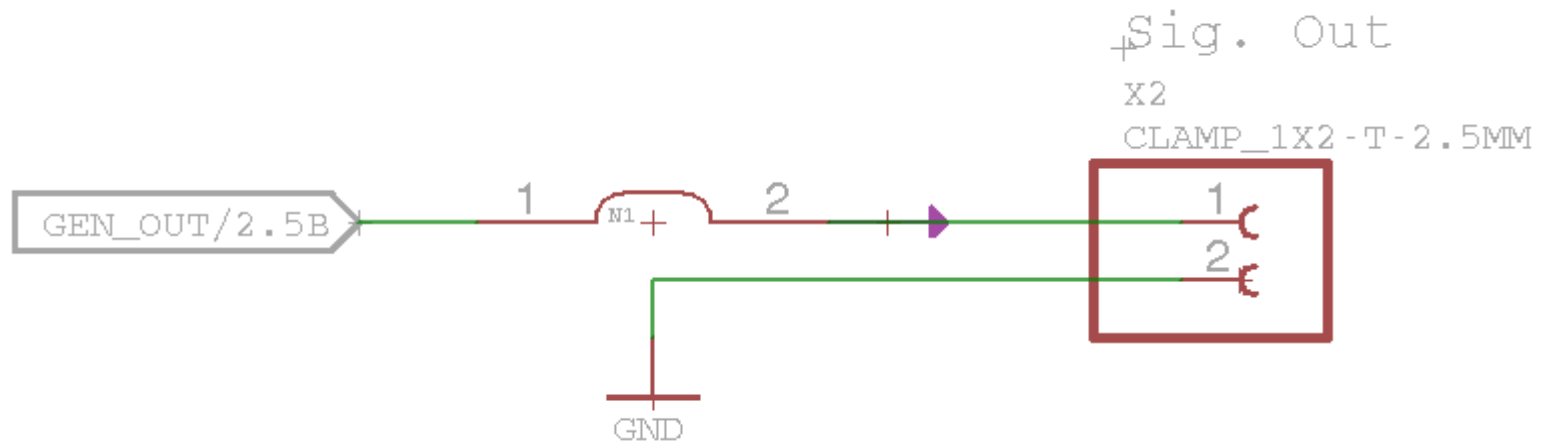
# Modularizing #3

ports or “netchanger”

- ◆ transition from one net to another
- ◆ follows the module concept in Verilog and VHDL



# Modularizing #4



# Modularizing #5

0.1 inch (0.5 0.0)

Add=next  
Swap=0  
pas 1 1 G\$1 2 pas 1

>NAME

2mm  
0.05in

Package	Variant	
S_NET_CHANGER_0.15MM	-S-0.15MM	✓
S_NET_CHANGER_0.3MM	-S-0.3MM	✓

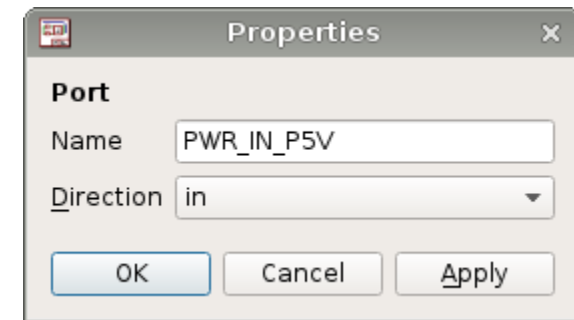
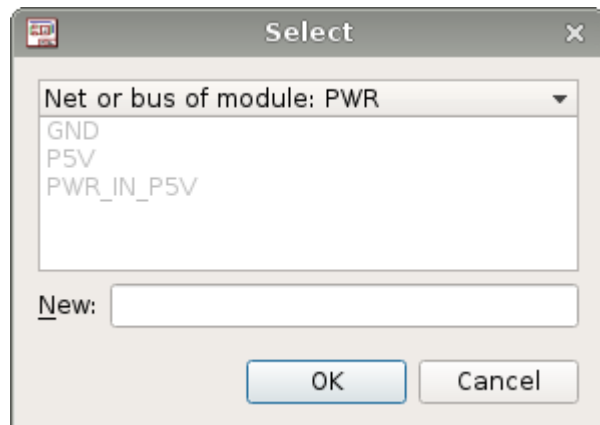
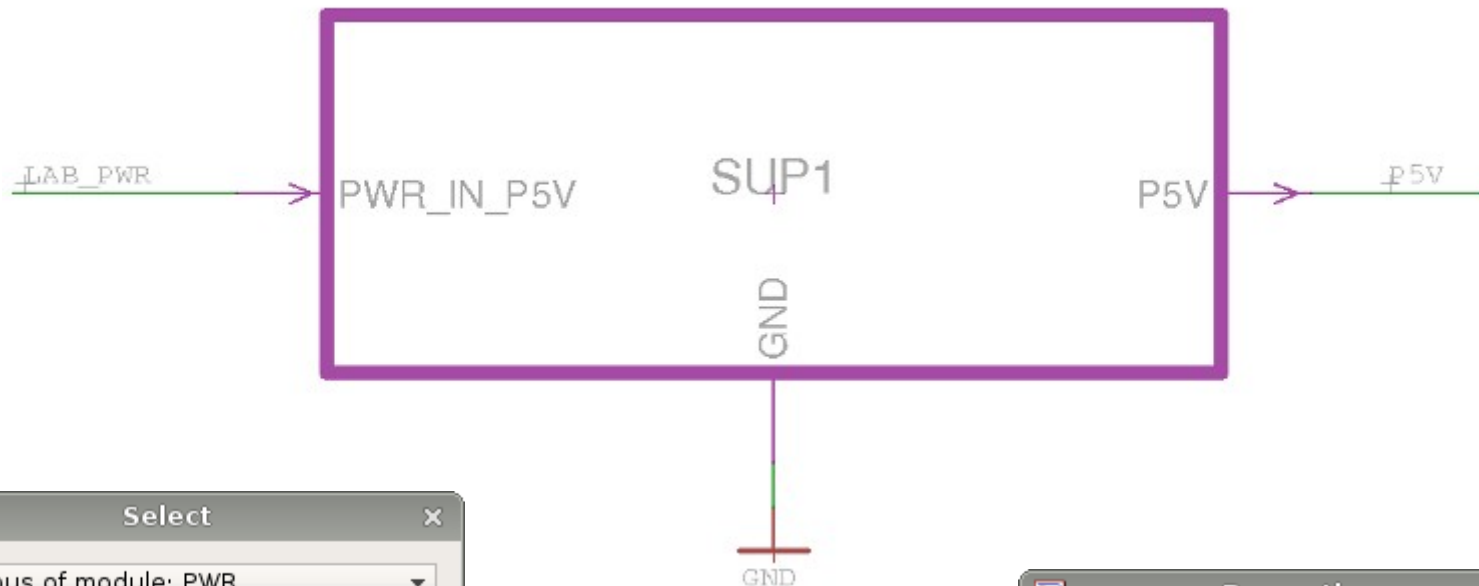
New Connect  
Prefix N  
Value  Off  On

**Description**  
drawn: Mario Blunk / Blunk electronic

Technologies	Attributes	
	BOM	COMMISSIONED
	FUNCTION	PART_CODE_BEL
	PART_CODE_EXT	UPDATED
NET_CHANGER-S-0.15MM	NO	2013-08-30
		N_PAC_S_NET_CHANGER_0.15MM

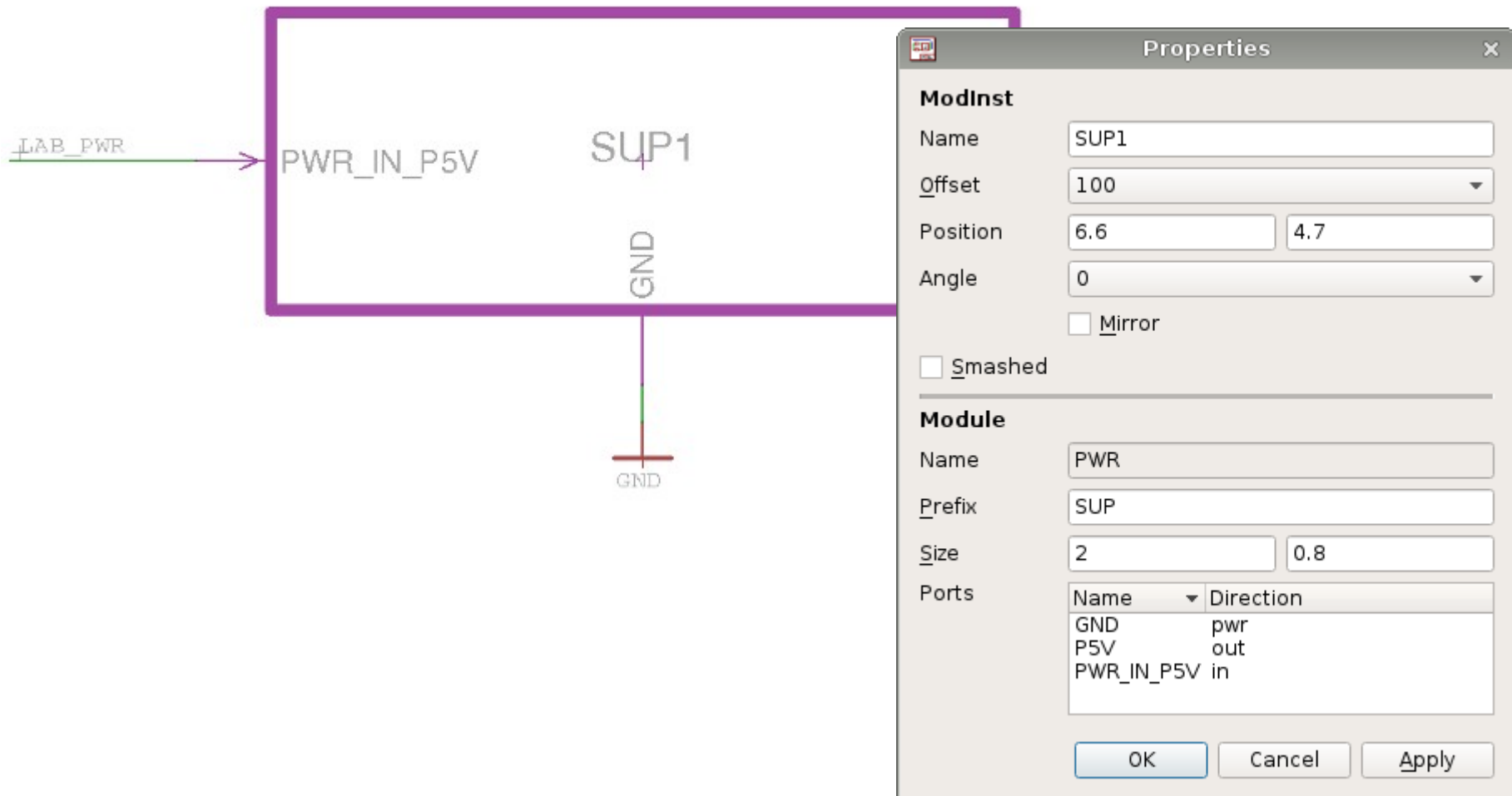
# Modularizing #6

Commands: MODULE, PORT, INFO, DELETE, MOVE (+ CTRL Key)



# Modularizing #7

Commands: MODULE, PORT, INFO, DELETE, MOVE (+ CTRL Key)



# Title Block #1

last update: 8/11/14 11:11 AM			
	Drawing Number: NCC-1701-F	Size: A4	<b>DEVELOPMENT</b>
Project:	Training	Drawn:	Schneider
		Checked:	Miller
		Approved:	Meyer
Description:		Sheet:	1/4
Filename:	square_wave_generator		
3	4	5	6

last update: 8/11/14 10:58 AM			
	Drawing Number: NCC-1701-E	Size: A4	<b>PRODUCT</b>
Project:	Training	Drawn:	Schneider
		Checked:	Miller
		Approved:	Meyer
Description:		Sheet:	3/4
Filename:	square_wave_generator		
3	4	5	6



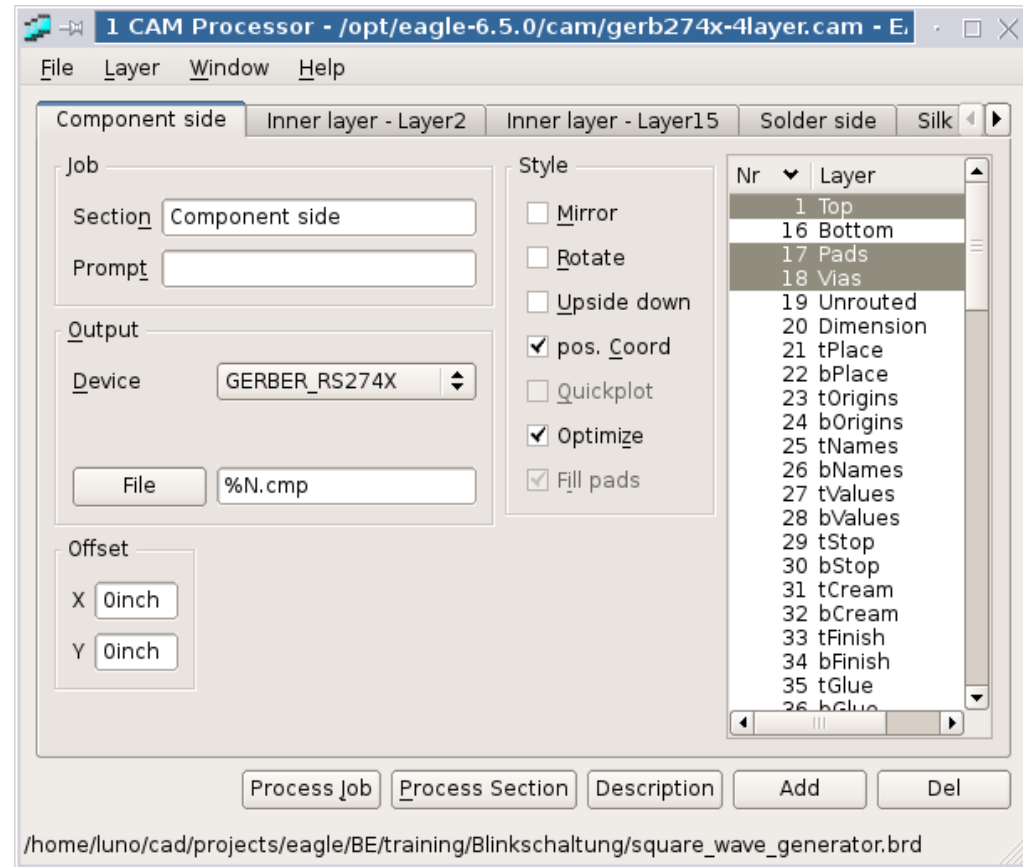
# Title Block #2

Name	Value
APPROVED	Meyer
CHECKED	Miller
DRAWING_NUMBER	NCC-1701-E
DRAWN	Schneider
PROJECT	Training

Last update: LAST_DATE_TIME		Size: A4		PRODUCT
Drawing Number: DRAWING_NUMBER		Drawn: DRAWN		
Project:	PROJECT	Checked: CHECKED		D
Description:		Approved: APPROVED		
Filename: DRAWING_NAME		Sheet: SHEET		
3	4	5	6	

# CAM – Processor #2

- 1) Via GUI  
or
- 2) Shell scripts  
(Linux only)



[https://github.com/Blunk-electronic/eagle\\_CAM\\_processor](https://github.com/Blunk-electronic/eagle_CAM_processor)

# CAM – Processor #3

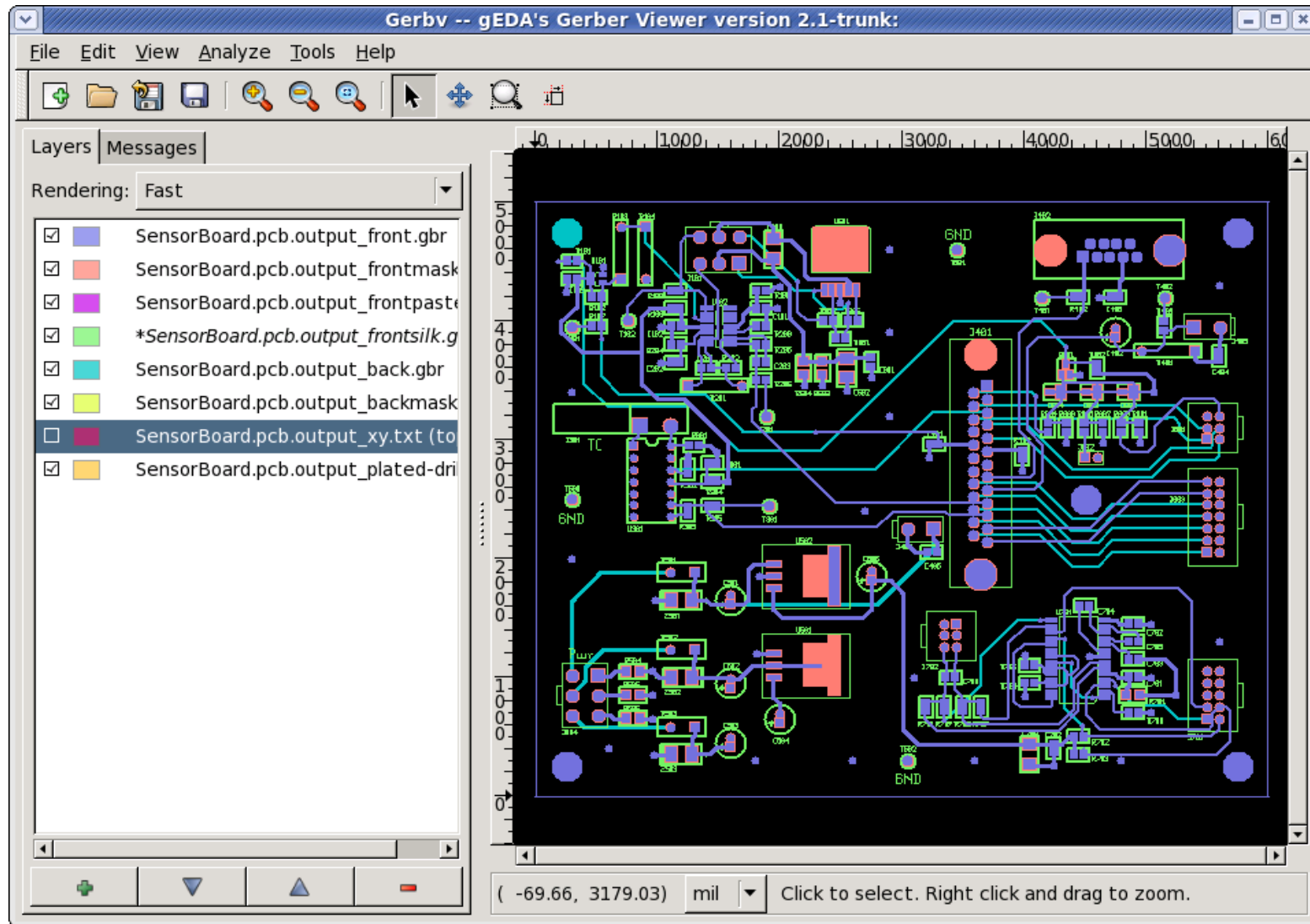
Shell scripts (*flexibility, interaction with OS/operator, ...*)

```
luno@luno:~/cad/projects/eagle/BE/training/sqw> mkcam sqw.brd 2
CAM file generator version 005
written by Mario Blunk / Blunk electronic / mario.blunk@blunk-electronic.de

board file given : sqw.brd
layer count      : 2

generating CAM files in directory 'cam/sqw_CAM_2014-08-11_1144' ...
- layer 1 (top) ...
- layer 16 (bottom) ...
- silk screen ...
- stop mask ...
- cream mask ...
- drills ...
- Drills Documentation ...
- plated millings ...
- outline ...
- documentation
dimensions, measures, document ...
dimension, tplace, tvalues, tdoc, document
dimension, bplace, bvalues, bdoc, document
dimension, tplace, torigins, tnames, tdoc, document ...
dimension, bplace, borigin, bnames, bdoc, document ...
```

# Gerber/Drill Viewer #1



<http://gerbv.geda-project.org/>

# *Gerber/Drill Viewer #2*

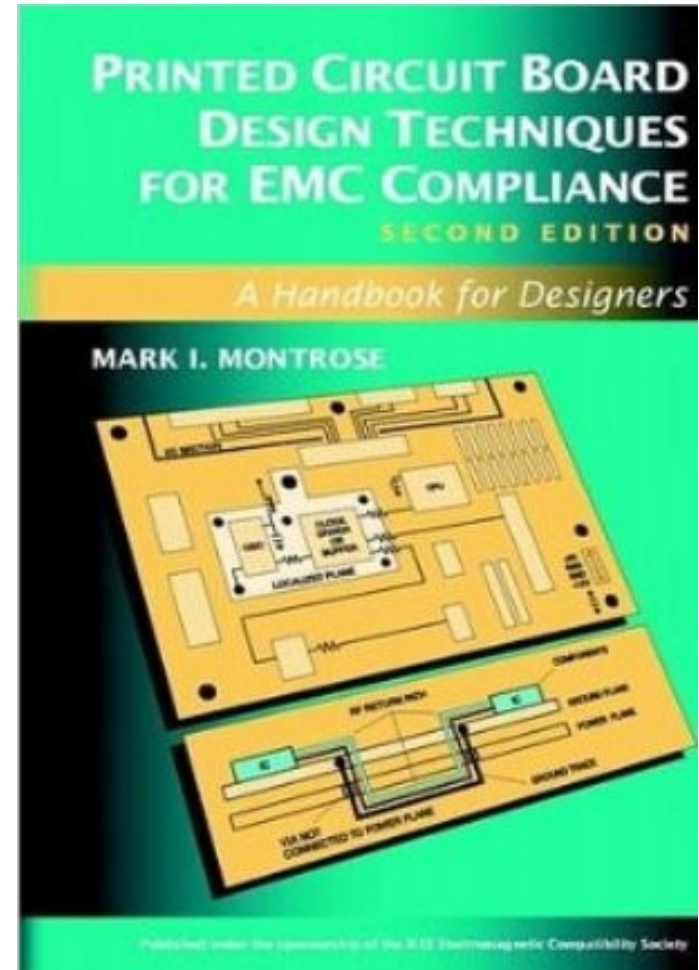


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Web: [www.pentalogix.com](http://www.pentalogix.com)

# Literature #1

Printed Circuit Board Design  
Techniques for EMC Compliance:  
A Handbook for Designers

(IEEE Press Series on Electronics  
Technology)



# Boundary Scan System M-1



Circuit Board  
Testing ?


**System M-1**

[click here !](#)

[What is Boundary Scan ?](#)

**JTAG/Boundary Scan System M-1**  
according to Std. IEEE 1149.1

- Minimal UUT access via 5 wire IEEE1149.1 test bus
- Fault diagnosis down to pin level
- Interconnect Test (short/open detection)
- Memory-Connect Test (RAM/ROM/FLASH)
- Oscillator Test / Clock Test
- LED, Display Test, Logic Test ...



- UUT Power Switch and Monitoring up to 6A / 48 V DC
- full galvanic separation of UUT from Scan Master in Non-Test Mode
- Operator Activity reduced by pushing START / STOP Button
- PASS / FAIL display by just two front panel LEDs

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info@blunk-electronic.de www.blunk-2.de Phone +49 361 518 9618 / +49 176 290 45 855

# *Links #1*



## *PCB Makers in Germany*

[www.q-print.de](http://www.q-print.de) (prototypes)

[www.jlp.de](http://www.jlp.de) (mass production)

## *German Part Distributors and assembly/EMS:*

[www.ax-electronic.de](http://www.ax-electronic.de)

[www.technikron.de](http://www.technikron.de)

[www.blunk-electronic.de](http://www.blunk-electronic.de)





# *Links #2*

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***Thanks for your attention !***